The Ocean Combat Academy (OCA) Framework: Version 1.0

A Proposal for Active Ocean Stewardship and Harmful Algal Bloom Mitigation

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Disclaimer: This is a conceptual proposal published for the purpose of soliciting feedback and collaboration. This document represents a vision in progress and is intended to stimulate discussion on innovative solutions for ocean stewardship. This document was developed by the author with the assistance of AI language models for ideation refinement and structuring.

1. The Vision

To establish a world-leading initiative that develops and deploys advanced technological solutions to actively mitigate ocean threats, beginning with harmful algal blooms (HABs), transforming environmental challenges into drivers of economic growth and ecological restoration.

2. The Core Problem

Harmful algal blooms are intensifying globally due to climate change and nutrient runoff, threatening marine ecosystems, coastal economies, and human health. Current strategies are primarily reactive or preventative; a proactive, removal-based approach is needed.

3. The OCA Shield: A Three-Tiered Solution

The OCA proposes an integrated, autonomous system for targeted HAB mitigation.

Tier Component Role Key Features
1. Perimeter Sentinel Buoys Continuous, passive filtering and monitoring of high-value zones (aquaculture leases, beaches). Toroidal buoy, 360° low-flow intake, solar-powered, real-time data relay.
2. Surface Swarm Drones Mobile**,** wide-area harvesting and buoy service. Agile catamarans, swarm AI, service and transport functionality.
3. **Subsurface Depth-Aware Harvesters** Precision targeting of deep algal layers. SWATH hull, retractable sensor mast & intake hose, storm-resistant ballast.

4. The Operational Workflow

1. Predict: AI models analyze satellite and sensor data to forecast bloom development.
2. Direct: The AI deploys the appropriate assets (Sentinels, Swarm, Depth-Harvesters) to optimal locations.
3. Harvest: Assets filter and remove algal biomass from the water column.
4. Process: Biomass is transported to a central harvester or onshore facility for valorization into products (fertilizer, biofuel).

5. Learn: All operational data feeds back to the AI, creating a continuously improving system.

5. Key Differentiators & Advantages

· **Proactive Removal:** Moves beyond containment to active extraction of biomass.
· **Depth Capability:** Addresses the entire water column, not just surface scums.
· **Circular Economy:** Transforms a waste problem into valuable products, creating a potential revenue stream.
· Resilience: A distributed system (swarm + static buoys) is fault-tolerant and scalable.
· **Data-Driven:** AI and real-time sensing ensure efficient and adaptive response.

6. A Phased Path to Realization

· **Phase 1 (Prototyping**): Develop and test filtration systems. Build a small-scale swarm drone and Sentinel buoy prototype. Secure pilot partnerships.
· **Phase 2 (Pilot Deployment):** Deploy a small fleet in a controlled environment (e.g., Spencer Gulf). Refine technology and business models.
· **Phase 3 (Scale & Expand):** Expand operations along the SA coast. Develop exportable technology packages for global application.

7. Anticipated Impact

· **Environmental:** Protection of marine ecosystems and coastal water quality.
· **Economic:** Job creation in advanced manufacturing, engineering, and blue tech; protection of aquaculture and tourism industries.
· **Scientific:** Positions South Australia as a global leader in marine robotics and environmental innovation.

8. A Call for Collaboration

The OCA framework is presented as a starting point for dialogue. We seek to engage with:

· Marine scientists and ecologists
· Robotics and naval engineers
· Government environmental and innovation agencies
· Impact investors and industry partners

We believe that by working together, we can evolve this concept from a blueprint into a reality, ensuring the health and prosperity of our oceans for generations to come.

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■ Ocean Combat Academy (OCA)

Autonomous Fleet — Prototype Design Catalogue

Innovating Ocean Stewardship Through Technology

Prepared by: The OCA Project

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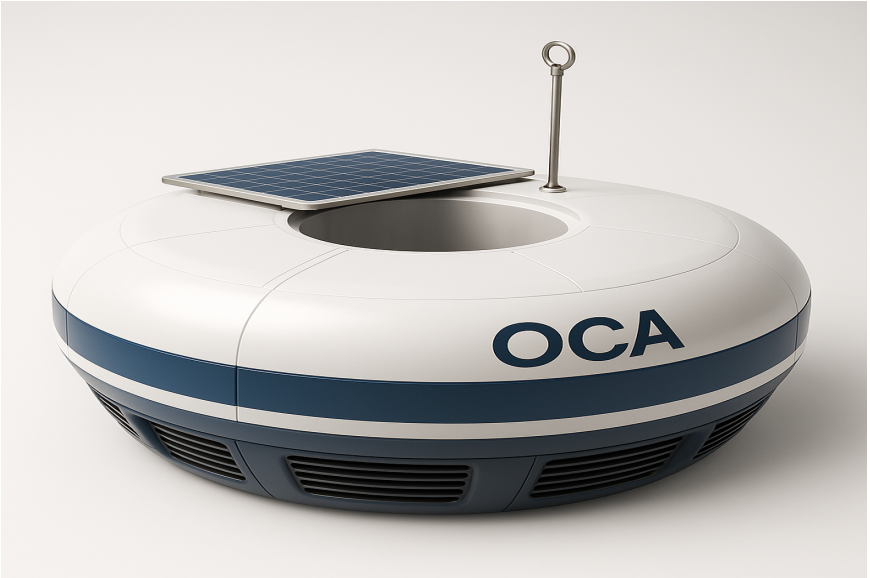
Perimeter Sentinel Buoy



Model Code: OCA-SB1

Type: Stationary Environmental Monitoring Buoy

Design Features:

- Toroidal Hull — stable, low-drift structure designed for all-weather deployment.
- Solar Deck — integrated photovoltaic panel provides continuous renewable power.
- Central Well — modular bay for sensor arrays and monitoring equipment.
- 360° Intake Grates — continuous low-flow filtration around the circumference.
- Communications Mast — real-time data relay and system integration.

Primary Role: Passive filtration and monitoring of coastal and aquaculture zones.

Surface Swarm Drone

Model Code: OCA-SSD1

Type: Autonomous Catamaran Service Drone

Design Features:

- Twin-Hull Catamaran — lightweight, agile design for high-speed navigation.
- Solar Power Array — deck-mounted panel ensures sustained autonomous operation.
- Hydrodynamic Intakes — bow-mounted filtration channels for surface harvesting.
- Swarm AI Integration — collective intelligence for coordinated, fleet-scale deployment.
- OCA Branding — bold white and blue livery for visibility and identity.

Primary Role: Mobile harvester and support unit for large-area bloom mitigation and buoy servicing.

Subsurface Depth-Aware Harvester

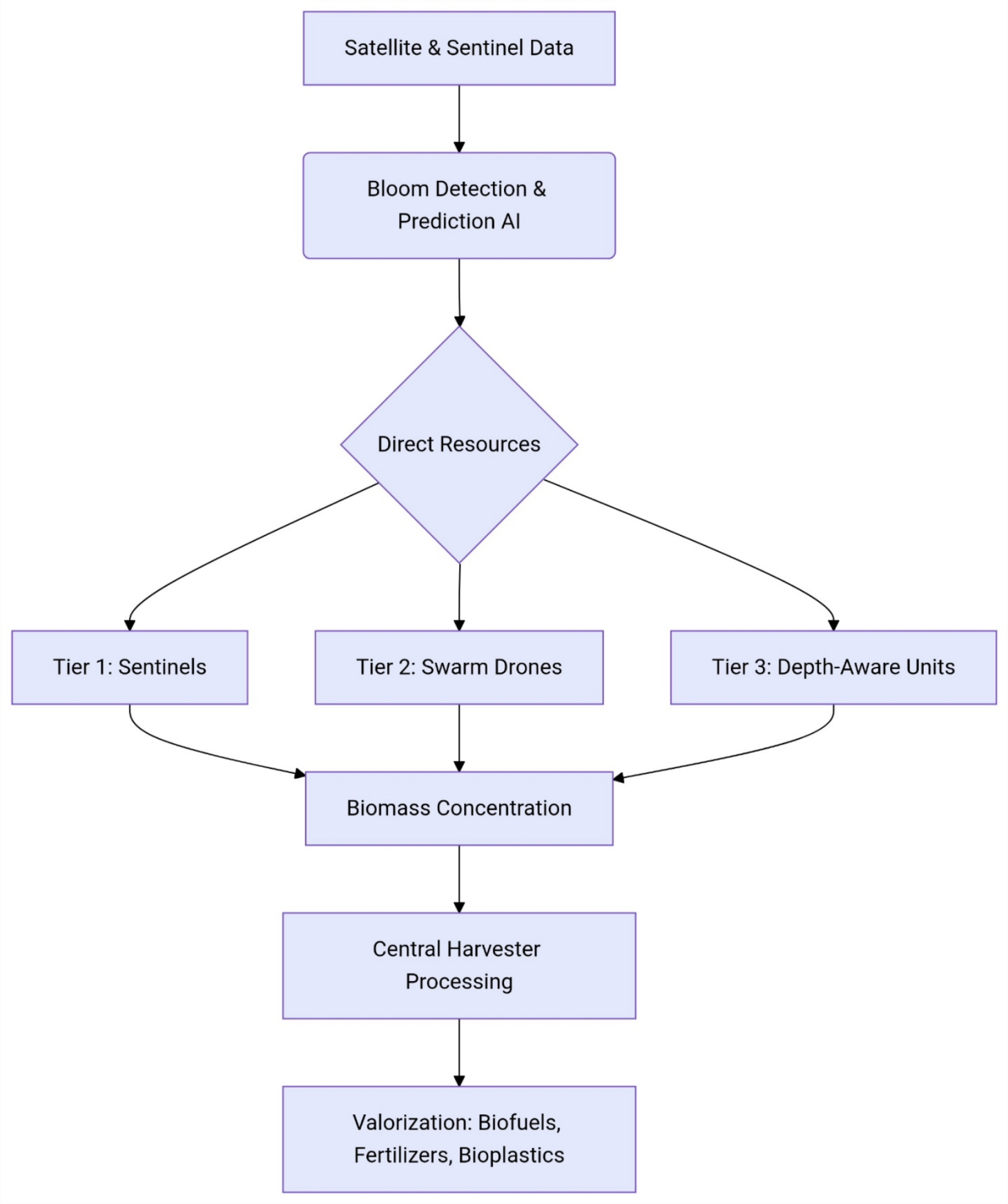
Model Code: OCA-DAH1

Type: Precision Subsurface Harvesting Vessel

Design Features:

- SWATH Hull — Small Waterplane Area Twin Hull for maximum stability in rough seas.
- Retractable Sensor Mast — equipped with advanced optics and comms hardware.
- Solar Power Deck — renewable energy supply for extended missions.
- Flexible Intake Hose — retractable harvesting line capable of targeting deep algal layers.
- Reinforced Structure — ballast-stabilized for storm-resistant operations.

Primary Role: Precision targeting of mid-water and deep algal concentrations beyond surface reach.


Satellite & Sentinel Data
Bloom Detection & Prediction AI
Direct Resources
Tier 1: Sentinels
Tier 2: Swarm Drones
Tier 3: Depth-Aware Units
Biomass Concentration
Central Harvester Processing
Valorization: Biofuels, Fertilizers, Bioplastics